B.Sc. Part-III (Honours) Examination, 2020

Subject: Physics

Paper: XI

(New Syllabus)

Time: 2 Hours **Full Marks: 50**

The figures in the margin indicate full marks. Candidates are required to give their answers in their own words as far as practicable.

SECTION-I

Answer any six (6) Questions **5×6 = 30**

1. Using appropriate circuit diagram, explain the principle of detection of FM signal. What is Carson's rule of thumb? **5**

2. With proper justification, find out the simplified boolean equation for the Karnaugh map of table below. Hence show the equivalent logic gate by AND-OR gate combination. **5**

	$\bar{C}\,\bar{D}$	$\bar{C}\,D$	CD	$C\bar{D}$
$\bar{A}\,\bar{B}$	0	0	0	0
$\bar{A}\,B$	0	0	1	0
AB	1	1	1	1
$A\bar{B}$	0	1	1	1

3. Assuming that each atom of copper contributes one free electron, calculate the drift velocity of free electrons in the copper conductor of cross-sectional area 10^{-4} m^2 carrying a current of 200 A. [Given atomic weight of copper = 63.5, density of copper = $8.94 \times 10^3 kg^{-3}$ and e = 1.602×10^{-19}C]. **5**

4. Using appropriate block diagram, explain the working principle of a feedback amplifier. An amplifier with an open loop gain of 25 is subjected to negative feedback of 10%. If thus the open loop gain increases by 5%, find the percentage change in gain with feedback.

5. Drawing the I-V characteristics of a Tunnel diode, explain the negative resistance region considering appropriate energy-band diagram. **5**

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6. Explain basic operation of depletion MOSFET with suitable schematic diagram. A common source FET amplifier uses a load resistance R_L = 200 kΩ. If the a.c drain resistance and trans-conductance of the FET are 100 kΩ and 0.15 mA/V, respectively, calculate the magnitude of the voltage gain of the amplifier. **5**

7. Realise a 4 bit resistive ladder D/A converter using resistors (R-2R ladder) and OPAMP. Hence show how it converters a 4 bit parallel digit word $A_3A_2A_1A_0$. **5**

8. A full wave rectifier uses two diodes. The internal resistance of each diode is 20 Ω. The transformer r.m.s secondary voltage from the centre tap to each end of the secondary is 50 V and load resistance R_L = 980 Ω. Find (i) the average current I_{dc}, (ii) r.m.s voltage across R_L and (iii) maximum rectification efficiency. **5**

SECTION-II

Answer any two (2) Questions **10×2 = 20**

1. (a) Drawing a self bias circuit, derive expressions for (i) collector current (Ic) and (ii) collector emitter voltage (V_{CE}) for the circuit.

(b) The hybrid parameters of a transistor used as an amplifier in CE configuration are: h_{ie} = 800 Ω; h_{fe} = 50; h_{oe} = 80x10^{-6} Ω and h_{re} = 5.5x10^{-4}. If the load resistance is 5 kΩ and the effective source resistance is 500 Ω, calculate (i) voltage gain, (ii) power gain and (iii) output resistance. 5+5 = 10

2. (a) Using appropriate diagram, explain electrostatic focussing of electron beam in a cathode ray oscilloscope.

(b) Discuss how a cathode ray oscilloscope may be used to measure the phase difference between two a.c. signals of the same frequency and amplitude.

(c) The length of the deflecting plates in a C.R.O is 5 cm. They are separated by 4 mm. The distance of the fluorescent screen from the nearest edge of the deflecting plates is 15 cm. A d.c voltage of 25 V is applied to the deflecting plates. If the accelerating potential difference is 1000 V, find the displacement of the spot on the screen. 3+3+4 = 10

3. (a) Calculate the actual output voltage of an integrator after 2 s for the input voltage of 1 V d.c. Given that input resistance = 100 kΩ and feedback capacitance 1 μF.

(b) Simplify the following expression:

$$ABC + \bar{A}BC + A\bar{B}C + \bar{A}\bar{B}\bar{C} + \bar{A}\bar{B}C + \bar{A}B\bar{C}$$

(c) A coil of 10 μH used in Colpitt's oscillator generates a wave of frequency 16 MHz. The transistor has h_{fe} = 50 and Δh_e = 0.5. Find the value of capacitance.

3+3+4=10

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4. (a) Using the equations of the unmodulated carrier and the modulating signal, obtain an expression for a frequency modulated signal in terms of carrier and modulated frequency. Hence draw the wave forms of carrier wave, modulating wave and the FM wave.

(b) Find the carrier and modulating frequency, the modulation index and maximum deviation of the FM wave represented by the voltage equation:

$$e_{AM}(t) = 12\sin\left(6\times10^{8}t + 5\sin(1250t)\right)$$

What power will be FM wave dissipate in a 12Ω resistor? 5+5=10